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Building Planning with the Application of Shell Structure on the Building Roof, Using the Tifa Philosophy Approach to Improve Local Character (Case Study of the Buti - Merauke Catholic Church Building)

Biatma Syanjayanta

Department of Architecture, Musamus University, Merauke 99614, Indonesia

ABSTRACT: This research conducted building planning activities by applying a shell structure to the roof of the building using the Tifa philosophy approach to elevate the local character in Buti village, Samkai sub-district, Merauke district, Merauke regency. The purpose of the Tifa philosophy approach is to represent local wisdom, namely a musical instrument that symbolizes joy for Indigenous Papuans (OAP). Philosophical design results with local wisdom, providing a suitable place of worship, which is able to accommodate all Buti parishioners, especially for OAP congregations, and elevating and preserving one of the historical sites in the city of Merauke and providing input to the local government regarding design plans in regional planning The results of this research are to apply the Shell Structure or shell structure in order to obtain philosophical design results with local wisdom, provide a decent place of worship, which is able to accommodate all congregations, especially for the OAP congregation, and raise and preserve one of the historical sites in the city of Merauke, South Papua Province, Indonesia.

KEYWORDS: shell structure, tifa, South Papua, futuristic and high-tech innovation, spherical geometry

INTRODUCTION

The St. Theresia Buti Church, the first church built on Animha land, remains intact and remains in a state of disrepair. Inside the church, there is evidence of the early arrival of Catholicism in Merauke. The arrival of Catholicism in Merauke marked the beginning of the development of Merauke's civilization to this day. This historical evidence can be seen in the preserved painting of the Pieta depicting St. Mary holding the body of Jesus Christ with the inscription "Regina Marthilum," painted by Vertenten, the first Dutch missionary. This painting adorns the church altar to this day.

The Clara Sukai Gebze monument was built by the Merauke Regency Government. This monument commemorates the arrival of the Gospel in Animha land, with the baptism of the first Marind, Clara Sokai Gebze, on August 14, 1905. Another historical landmark on the site of the St. Theresia Buti Church is the tomb of the Patale Sai Imbuti Mission. The graves of Dutch and indigenous missionaries from the Merauke Archdiocese are located at the rear of the church grounds. In 2005, the graves were filled with the bones of missionaries, nuns, and brothers, placed in a specially prepared burial place.

The presence of the church at that time significantly influenced the development of the community around the research site. This influence apparently also fueled the Marind-anim's enthusiasm for participating in village development, fostering harmony among villagers and sub-districts of different faiths. Furthermore, non-governmental organizations with religious and Christian backgrounds played a significant role in motivating the local community.

The current condition of the building is no longer able to accommodate the congregation, due to the rapid growth of the congregation itself, both immigrants and indigenous Papuans (OAP). During worship services, the small church space makes it impossible to accommodate the congregation inside, so a makeshift space has been created outside the main building. Congregants at the Sta. Theresia Buti Church even stand outside the church fence, which not only hinders the congregation from worshipping solemnly but also disrupts and endangers the safety of both the congregation and pedestrians.

The objectives of this research are to obtain a philosophical design based on local wisdom, provide a suitable place of worship that can accommodate all members of the congregation, especially the indigenous Papuan community (OAP), and highlight and preserve a historical site in Merauke City. This research question concerns how to design a building using a shell structure on the roof using the Tifa philosophy to enhance the local character of Buti Village, Samkai Subdistrict, Merauke Regency. The purpose of the Tifa philosophy is to represent local wisdom, namely a musical instrument that symbolizes joy for Indigenous Papuans (OAP).

The purpose of this research is to conduct building planning activities by applying a shell structure to the roof of the building with a tifa philosophy approach in order to

elevate local characters that are adaptable to the surrounding environment, by using the s-curve method as a means of scheduling work implementation on a Catholic church building in Buti village, Samkai sub-district, Merauke district in Merauke regency. The purpose of the Tifa philosophy approach is to represent local wisdom, namely a musical instrument that symbolizes joy for Indigenous Papuans (OAP).

LITERATURE REVIEW

This research was conducted in Buti village, Merauke district, Merauke regency, South Papua province. This village is predominantly inhabited by indigenous Papuans (OAP).

Samkai Village is a village administrative area consisting of several villages: Nowari, Buti, Yowati, Yobar, and Payum. These villages were originally Marind villages. However, they are now also inhabited by other ethnic groups or non-Marind residents. According to the Samkai Village monograph, 45% of the OAP population in this village are Marind, the original inhabitants of this village, and the remainder are non-Marind. Samkai Village is located on the western coast of Merauke City, a suburb of Merauke City.

Figure 1. Map of research location

The development of the Samkai district, particularly Buti village, is influenced by religion in addition to customs. The influence of religion (the Church) here refers to the influence of Christianity, particularly the Catholic Church, on Marind-anim in various aspects of life. The direct influence of Christianity as a supporter for Marind-anim is experienced through parochial congregation activities. This influence has also fueled Marind-anim's enthusiasm for participating in village development, fostering harmony among villagers and sub-districts of different faiths. Furthermore, non-governmental organizations with religious and Christian backgrounds have played a significant role in motivating the local community to develop their socio-economic and educational lives. These institutions include the Catholic School Education Foundation (YPPK) for education. Meanwhile, the Social Delegation of the Merauke Archdiocese, Yasanto (Antonius Foundation), and the Mitra Karya Foundation are active in the socio-economic sector.

The church building of St. Theresia Buti is one of the Catholic churches under the Archdiocese of Merauke. The Archdiocese of Merauke is a metropolitan Ecclesiastical Province in unity with four neighboring suffragan dioceses: Agats, Jayapura, Manokwari-Sorong, and Timika. The Archdiocese of Merauke is a metropolitan diocese with a relatively high percentage of Catholics compared to other dioceses in Papua. Its territory covers Merauke Regency, Boven Digoel Regency, and most of Mappi Regency, South Papua.

The church building of St. Theresia Buti is the first church built on Anim Ha land. The church's appearance remains intact and is in a state of disrepair. Inside the church building is one of the earliest historical evidences of the arrival of Catholicism in Merauke. The arrival of Catholicism in Merauke was the forerunner to the development of Merauke's civilization to this day. This historical evidence can be seen in the surviving painting of the Pieta, depicting St. Mary holding the body of Jesus Christ, with the inscription "Regina Marthilum," painted by Vertenten, an early Dutch missionary. This painting still adorns the church altar today.

Figure/Ground Theory, Linkage, and Place. Figure/ground theories are understood from urban planning as the textural relationship between built form (building mass) and open space. Figure/ground analysis is an excellent tool for identifying the texture and patterns of an urban fabric, as well as identifying problems of irregularity in urban mass/space [1].

Figure/Ground Theory describes the totality of an area. Its function is to demonstrate the texture of the city through the solid form of the building mass and the void of open space. The relationship between mass and space is shaped by the shape and location of the building, the design of site elements (planted walls), and the flow of movement, resulting in six patterns: grid, angular, curvilinear, radial/concentric, axial, and organic [2].

Figure 2. Site figure ground

Figure 3. Site figure ground

Site figure ground analysis is an excellent tool for identifying the texture and spatial patterns of a site (site plan), as well as identifying problems of mass/space irregularities within the site.

The Tifa is a traditional musical instrument in Papua, made of wood with a membrane made of animal skin. It is classified as a single-headed frame drum. Its origins are closely linked to folklore. The body of the Tifa is decorated with specific motifs according to the beliefs of its supporters. This musical instrument is played by a player by striking the membrane with a four-pattern rhythmic pattern. In a socio-cultural context, the Tifa serves as an attribute of the greatness of the Ondoafi (tribal chief), as a means of communication, a means of connecting with God, ancestors, and other natural forces. As a product of expressive culture, this musical instrument is used to accompany wor singing and dance. Papuan society interprets the Tifa as a cultural work that serves as a symbol of identity, provides identity, and strengthens social relations.

Figure 4. Tifa Musical Instrument

A shell structure is a plate curved in one or more directions with a thickness much smaller than its span [3]. Meanwhile, according to Schodeck (1998), a shell is a rigid, thin, three-dimensional structural form with a curved surface [4]. In line with the above definition, a shell is thin and curved. Therefore, a thin, flat structure or a thick, curved structure cannot be considered a shell [5].

The term shell refers to a shell. A thin shell is a curved membrane thin enough to exert negligible bending stresses on most of its surface, but thick enough that it will not buckle under small compressive stresses, as would occur in an ideal membrane [6]. Under load, a thin shell is stable under any gentle load that does not excessively strain the plate, because the shell does not need to deform to avoid the development of compressive stresses.

A thin shell can support a gentle load with membrane stresses, and the membrane stresses exerted within a shell depend primarily on the conditions of its boundary supports. The conditions that must be met to induce pure membrane stresses within a shell include:

a. The reactive forces at the shell boundary must be equal and opposite to the membrane forces at the boundary caused by the load.
b. The supports must allow the shell boundary to experience displacements caused by membrane strain. If one or both of these conditions are not met, bending stresses will develop within the shell due to:
   1) Meridional forces are internal forces in an axisymmetric shell that are evenly distributed and expressed as force per unit area.
   2) Circular forces are expressed as force per unit length and can be obtained by considering equilibrium in the transverse direction.
   3) Force distribution: The distribution of circular and meridional forces can be obtained by plotting the equations of the two forces. Meridional forces are always compressive, while circular forces undergo a transition at an angle of 51° to 49° measured from the vertical.
   4) Concentrated forces: these loads must be avoided in shell structures.
   5) Support conditions: these conditions significantly affect the behavior and design of the structure. Ideally, the supports should not induce bending moments on the shell surface. Therefore, pinned conditions should be avoided. Using hinge connections is the same as applying forces to the shell edge, which will generate bending moments.

6) Membrane stress in a thin shell. A curved membrane is thin enough to exert negligible bending stresses over most of its surface, but thick enough that it will not buckle under small compressive stresses, as would a thin shell. Under load, a thin shell exerts membrane stresses, namely tensile, compressive, and tangential shear stresses. A thin shell is stable under any gentle load that does not excessively strain the plate, because the shell does not need to deform to avoid developing compressive stresses. A shell must be properly supported. A proper support is one that:
   (a) Exerts membrane reactions, that is, reactions acting in a plane tangent to the shell at the boundary and
   (b) Allows membrane displacements at the shell boundary, that is, displacements caused by strains due to membrane stresses.

If the support reactions are not in the tangent plane of the shell or if the membrane displacements are prevented by

the supports, the shell will exert boundary bending stresses. If the shell shape and the support conditions are both chosen inappropriately, the shell may direct bending stresses over its entire surface. Such an inappropriately designed shell cannot act as a thin shell, and therefore cannot carry most of the load through the membrane stresses.

The Sydney Opera House, with its futuristic design and high-tech innovation, represents a challenge in the field of architecture that has been successfully realized. This success has provided a motivation for the world of future architecture by presenting an impressive architectural work. Designed by Danish architect Jorn Utzon in 1959, it spans 1.8 hectares of land for 14 years, with a roof height reaching 67 meters above sea level. It features a "sperical geometry" design consisting of 2,194 precast concrete sections. The shell used on the roof of the Sydney Opera House is a free-form shell. Where the existing shell shape does not follow a geometric pattern but is structurally bound. Although the geometric shape remains, it is not the main factor. The forces experienced by this shell structure are still calculated according to its structural principles. However, this does not limit the architect's ability to explore ideas and concepts in his work. This is reflected in the design of the Sydney Opera House, which can inspire subsequent architectural works.

Figure 5. Sydney Opera House in Australia

Figure 6. Keong Mas Imax Theater in Jakarta, Indonesia

The Keong Emas Imax Theater was founded on the initiative of the late Hj. Mrs. Tien Soeharto, and began operating on April 20, 1984, intended as an educational recreational facility to introduce the nation's natural and cultural riches through giant screen (audio-visual) film screenings using the sophistication of modern cinematography technology, the IMAX Projector, by showing the film "Beautiful Indonesia".

RESULTS AND DISCUSSION

Results

The placement of the building with a roof resembling a Tifa musical instrument is adjusted to the condition of the land/site.

Figure 7. The roof of the building resembles a Tifa musical instrument.

Figure 8. Top View Plan

The roof of the church building uses a shell structure. A shell is a rigid and thin three-dimensional structural form that has a curved surface. The shell surface can have any shape. Common shapes are surfaces derived from curves rotated about one axis such as spherical, elliptical, conical and parabolic surfaces, translational surfaces formed by sliding a plane curve over another plane curve such as elliptical and cylindrical parabolic surfaces, surfaces formed by sliding two ends of a line segment on two plane curves such as hyperbolic paraboloid and conoid surfaces and various shapes that are combinations of those mentioned above.

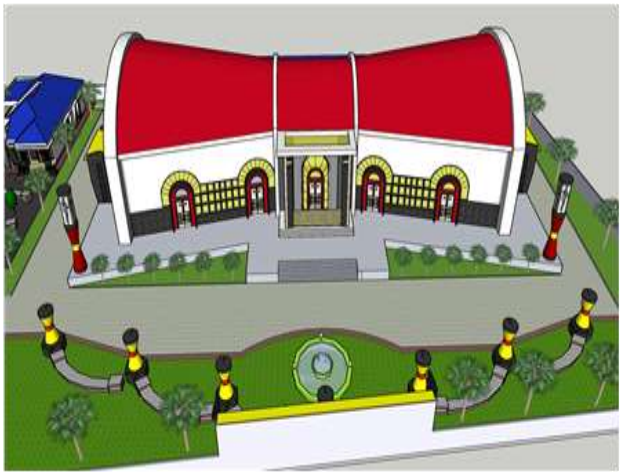

Figure 9. Front view plan of the building

Loads acting on the shell surface are transmitted to the ground by generating in-plane shear, tensile, and compressive stresses. The thinness of the shell surface results in no significant moment resistance. Thin-shell structures are particularly well-suited to supporting evenly distributed loads on building roofs, and they are unsuitable for resisting concentrated loads.

Figure 10. Structural Elements in Side View

As a result of the way these elements carry in-plane loads, primarily in tension and compression, shell structures can be very thin and have relatively large spans. Span-to-thickness ratios of 400 or 500 are possible, for example, a thickness of 3 in. (8 cm) might be used for a dome spanning 100 to 125 ft (30 to 38 m). Shells this thin use relatively recently developed materials, such as reinforced concrete. Other dimensions, such as masonry domes, have greater thickness and cannot be classified as structures that only carry in-plane tension because in such thick structures the bending moment begins to dominate.

Figure 11. Perspective plan in building

The shape of the roof of a building with a shell structure is made circular or curved upwards. Circular forces, expressed as a force per unit length that can be obtained by reviewing the balance in the transverse direction. The distribution of forces, the distribution of circular and meredional forces can be obtained by plotting the equations of the two forces. The meredional force is always compressive, while the circular force experiences a transition at an angle of 51 49' measured from the vertical line measured from the vertical line. Concentrated forces, this load must be avoided from the shell structure. Support conditions, this condition greatly affects the behavior and design of the structure. Ideally, the support should not cause a bending moment on the shell surface. So the clamped condition must be avoided. Using a hinge connection is the same as applying a force to the shell edge, which means it will cause a bending moment. should not cause a bending moment on the shell surface. So the clamped condition must be avoided. Using a hinge connection is the same as applying a force to the shell edge, which means it will cause a bending moment.

CONCLUSION

The results of this research are to apply the Shell Structure or shell structure to obtain philosophical design results with local wisdom, provide a decent place of worship, which is able to accommodate all congregations, especially for the OAP congregation, and raise and preserve one of the historical sites in the city of Merauke, South Papua Province.

This design is a recommendation to the local government to raise and preserve one of the historical sites in the city of Merauke and by implementing a structure that is able to pursue philosophical building forms in order to raise the character and identity of a city in this case the Merauke regional government so that it can bring out a historical effect.

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